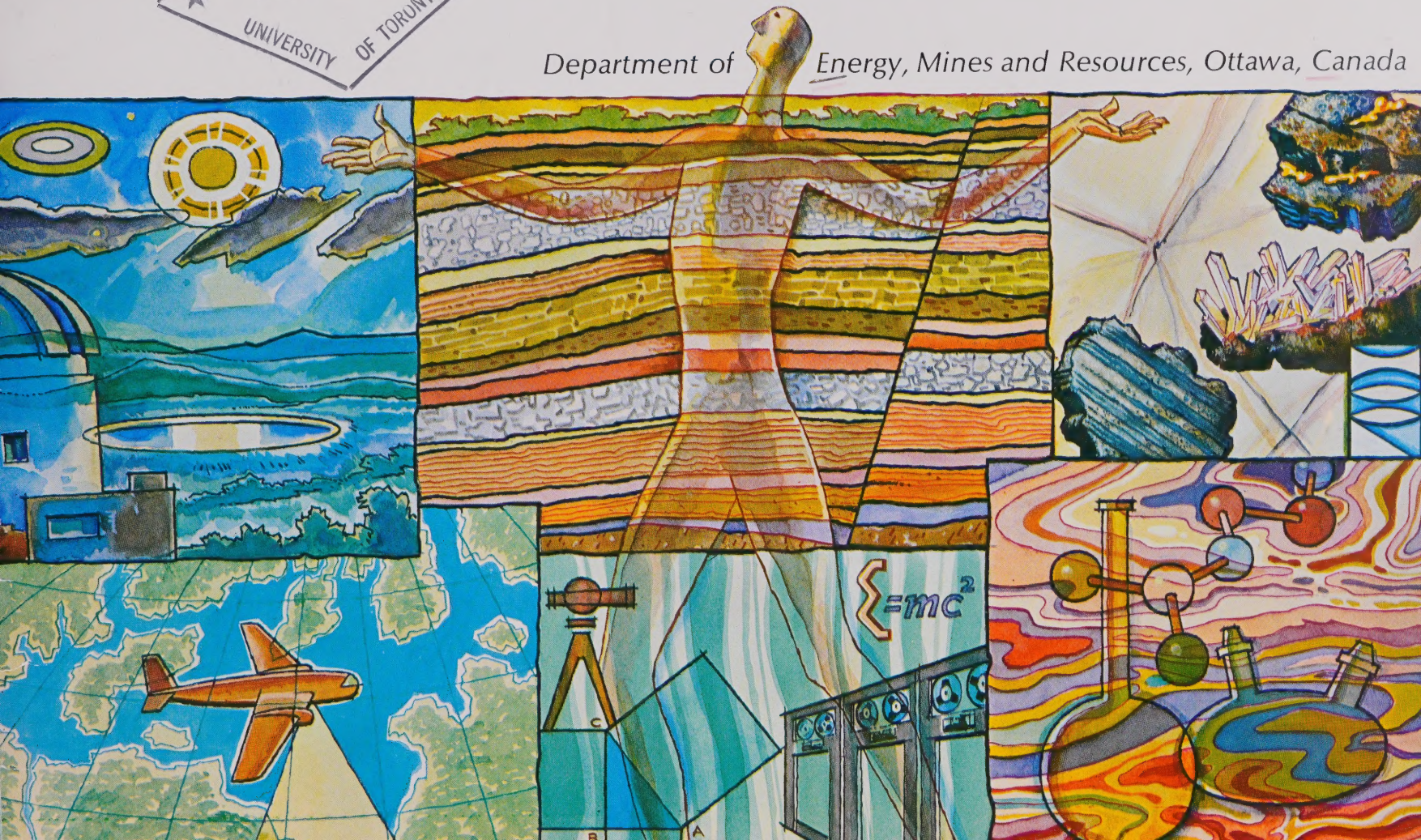
earth sciences * careers for university graduates

Department of Energy, Mines and Resources, Ottawa, Canada



DEPARTMENT OF
ENERGY, MINES
AND RESOURCES
OTTAWA, CANADA

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Graduates in the natural sciences, engineering, mathematics and administration, with an interest in Canada's natural resources, will find absorbing careers in earth science research.

The Mines and Geosciences Group of the Department of Energy, Mines and Resources carries out a broad range of scientific research and other activities, directed toward the exploration, economic use and conservation of the country's natural resources and requiring the combined efforts of many kinds of scientists, engineers and technical assistants. The central research facilities are located in Ottawa and there are regional facilities in many parts of Canada. Field investigations are undertaken in all parts of the country.

The Group comprises four branches: the Surveys and Mapping Branch, the Geological Survey of Canada, the Mines Branch and the Observatories Branch.

Opportunities

The new graduate may join scientific research groups or engineering teams to solve basic problems in geology, mineralogy, geochemistry, geophysics, astronomy and other earth science disciplines *or* he may be involved in the application of earth science knowledge to Canada's economic and sociologic problems *or* he may participate in the inventory of earth science data throughout Canada. He will be encouraged to develop his individual capabilities and to exploit his potential for research. He will have ample opportunity to present his work to the scientific community through departmental publications and outside journals, as well as participation in national and international scientific meetings. The basic financial remuneration is commensurate with salaries in other earth science institutions, and the application of the merit principle allows outstanding researchers to receive considerably higher rates of remuneration.

careers in earth sciences

There are career opportunities for new graduates in the following fields.

The Surveys and Mapping Branch

Administration
Cartography
Geography
Land Surveying
Mathematics
Physics
Survey Engineering

The Geological Survey of Canada

Administration
Chemistry
Geochemistry
Geology
Geomorphology
Geophysics
Mathematics
Mineralogy
Paleontology
Petrography
Petrology
Physics
Sedimentology
Stratigraphy

The Mines Branch

Administration
Applied Mathematics
Chemistry and Fuel Chemistry
Engineering
- Chemical
- Civil
- Electrical
- Mechanical
- Metallurgical
- Mining

Mineralogy
Physics and Engineering Physics

The Observatories Branch

Administration
Astronomy
Geology
Geophysics
Mathematics
Physics

the mines and geosciences group

The Surveys and Mapping Branch

The Surveys and Mapping Branch maintains and extends a network of horizontal and vertical control points across Canada, carries out the topographical mapping of the country at scales varying from 1:25,000 to 1:1,000,000 as well as legal or property surveys on Crown lands; it participates in the survey and demarcation of interprovincial and territorial boundaries, prepares descriptions and diagrams of federal electoral districts and is the sole agency in Canada for the preparation of aeronautical charts. The Branch is also responsible for the production of the *National Atlas of Canada,* which includes maps representative of many disciplines. It produces the thematic maps for the *Atlas* and for various other purposes within the Department and for other government agencies.

Survey engineering

Graduates in survey engineering (surveying) analyze and develop survey systems and plan, conduct and evaluate control, mapping and charting surveys.

Geodesists study the size and shape of the earth using data from triangulation, trilateration, astronomy, gravity and geodetic satellites and establish a control grid throughout Canada.

Astronomers use sensitive theodolites to make observations for the precise determination of azimuth and of the deflection of the vertical.

Photogrammetrists develop methods and equipment to make maps better and more economically through the use of aerial photographs.

Mathematics and computer science

Graduates in mathematics and computer science make statistical analyses of survey data, and develop techniques and computer programs for the automation of map and chart production.

Engineering physics and electronics

Graduates in engineering physics and electronics are involved in the design and maintenance of electronic distance measuring equipment and in the interfacing of electronic computers with existing sensing devices and display systems.

Geography and cartography

Geographers are responsible for thematic maps, depicting the nature of Canada in terms of its physical characteristics (terrain, climate, vegetation, etc.), its population characteristics, and its economic characteristics (natural resources, industries and values of production). They also work on selected historical subjects that help to explain present conditions. The work is presented in the form of atlases, primarily the *National Atlas of Canada,* and as individual maps.

Cartographers design and compile both topographic and thematic maps at various scales, for the portrayal of many natural and cultural aspects of Canada. In addition to the classic methods of cartography, they use many modern techniques of both the graphic arts and printing trades to enable them to display the required information most effectively. They also design and produce charts for air navigation.

Land surveying

Land surveyors facilitate the administration, development and use of territorial and other lands and resources, Indian Reserves and National Parks by establishing, maintaining and documenting legal property boundaries and furnishing other related professional services to client departments. They participate in formulating appropriate methods and standards and in evaluating the work done.

The Geological Survey of Canada

The Geological Survey of Canada investigates, describes and explains the geology of Canada. It helps to determine the country's mineral potential; it provides the mineral and petroleum industries with data and guidance for intelligent exploration for, and discovery of the nation's mineral deposits, and it assists planning and development by providing data fundamental to engineering projects, land use, water supply and the exploitation of other resources. The Survey maintains offices

and research facilities at Ottawa, Calgary and Vancouver.

The first reconnaissance coverage of Canada is nearing completion and the geological explorer of the past is being replaced by specialists in the varied disciplines of earth sciences. Research in field and laboratory problems, identified in the reconnaissance phase, is under way to understand the geological evolution of the country. Specialists in regional geology, paleontology, sedimentology, mineralogy, geochemistry, geophysics, economic geology and other earth science disciplines have been joined by chemists, physicists, botanists, mathematicians and engineers. Together they provide new techniques, new types of quantitative data and new means of processing and interpreting them. Through participation in multidisciplinary projects, they contribute to the search for new mineral wealth below the visible rock outcrops and thus aid the closer definition of the nation's mineral potential. The results of their research are published in the Memoirs, Bulletins, Papers and maps of the Geological Survey and in numerous scientific and technical journals.

Geology

Geologists divide their time between the field study and explanation of geological phenomena and the laboratory study of geological materials and processes.

Regional geologists examine the areal distribution and evolution of rock units. Specialists in structural geology, stratigraphy, petrology, paleontology, geomorphology, engineering geology and economic geology study specific facets of the regional geology to contribute their specialized knowledge to problems of economic and scientific significance.

Economic geologists study all aspects of the geology of mineral deposits and the metallogeny of useful elements and minerals. This comprehensive research provides a scientific basis for exploration and assessment of mineral potential in Canada; it includes systematic recording and appraisal of geological data, geological classification of deposits, definition of criteria for recognition of each type of mineral occurrence, and the development of concepts and hypotheses on the geological environment, provenance and genetic processes of economic mineral deposits.

Stratigraphers, paleontologists and sedimentologists work in close association in studying the stratigraphy and historical framework of the stratified sedimentary rocks which are the hosts of Canada's large resource of oil, natural gas and coal. A program, just beginning, in the Western Plains and Arctic regions is designed to assist in understanding the sedimentology, environment of deposition, diagenesis and compaction of these sedimentary rocks, particularly as it relates to the migration and accumulation of petroleum and natural gas.

Engineering geologists conduct research on aspects of geology that affect the engineering behavior of unconsolidated (soil) materials and carry out geological investigations of engineering sites.

Quaternary geologists study the nature and stratigraphy of the unconsolidated deposits, the landforms produced during the most recent or Quaternary period, and the environments they represent. These deposits are the parent materials of our forest and agricultural soils, and the source of our sands, gravels, clays and other industrial minerals; they form the foundations for most man-made structures such as buildings, dams and engineering structures of many kinds. Quaternary paleoecologists investigate the chronology of fossil-bearing deposits and conduct research on changes of environment and in plant and animal distribution during the recent past.

Geomorphologists study the processes by which the present landscape in various environments is being changed and apply this knowledge for interpretation of rocks and soils of earlier eras.

Geochemistry

Geochemists are concerned with the chemistry of the whole earth and its component parts, and with the distribution and movement of the chemical elements in them. Geochemists of the Geological Survey study the geochemical characteristics of Canadian crustal rocks and surficial deposits (including biogeochemical and geobotanical aspects) with emphasis on those elements of known or potential economic value. Much of the Survey's program in geochemistry is directed to the development of new methods and techniques of prospecting for mineral deposits. Laboratory investigations are carried out both in mobile field laboratories and in major research laboratories,

equipped with a wide range of analytical facilities.

Geophysics

Geophysicists aid the regional geologist by conducting and interpreting aeromagnetic and seismic surveys , the economic geologist by conducting experimental surveys over ore deposits and the Quaternary geologist and hydrogeologist by seismic, resistivity and airborne sensing surveys. In addition, geophysicists carry out pure and applied research in paleomagnetism, the development of geophysical prospecting methods and instruments, on computer methods of interpreting geophysical data and on methods of airborne sensing.

Mineralogy

Mineralogists study the physical and chemical properties of minerals, the occurrence in the field and geologic significance of mineral associations and textures and the physical and chemical characteristics of mineral environmental habits. Mineralogists investigate and apply techniques of X-ray diffraction, emission and absorption, and electron microscopy and microanalysis, compile data on Canadian minerals, and assemble and study the minerals in the National Mineral Collection.

Chemistry

Chemists use many chemical and instrumental methods to provide compositional data for most of the chemical elements in all concentration ranges in all types of geological samples from Geological Survey projects. A continuous program for the development of new methods and the testing of methods and techniques is a necessary and important part of the analytical work.

Physics

Physicists apply the properties of natural radioactive and stable isotopes to unravel the ages of rocks in Precambrian and later times as well as to interpret processes of formation and alteration of rocks.

Mathematics

Mathematicians develop and apply electronic data processing methods and geomathematical techniques to the quantitative definition and interpretation of geological problems. This is a new and challenging field. Mathematical models are evolved to assist in determining the distribution of economic elements in mineral deposits and in predicting geological areas of major economic importance.

The Mines Branch

The Mines Branch is an interdisciplinary material science institution engaged in research in nonrenewable mineral resources and metals. Its facilities include a Mining Research Centre which carries out research, such as stability of underground and open-pit mines, methods of rock breakage, problems of environmental engineering and methods of obtaining maximum performance in mining operations.

The Branch's general objective is to provide leadership in ensuring a sound scientific base for new technology and in stimulating the application of advanced technology to the extraction, processing and use of minerals and fuels in Canada and in the improvement of metal products.

Specifically, it aims to improve the efficiency of the mining, processing and use of mineral resources and of metals and alloys; to minimize waste and improve the recovery of irreplaceable mineral resources; to recognize problems in industry and undertake research, or give advice, on methods of solving these problems; to predict shortages and substitutions from technological market trends; and to undertake research on mineral resources of potential value.

It plans its activities in terms of both basic and applied research, the ratio between the two being capable of variation as required by the changing needs in technology. As a corollary, the Branch has had to build up some facilities to support its specialized activities, such as facilities for the carbonization of coal, the study of corrosion, and for pilot-scale mineral processing and foundry investigations.

Physics and engineering physics

Physicists and engineering physicists carry out research on materials, mainly minerals and metals, for example, in solid state, crystal structure studies, metal physics, solidification, electrical transport phenomena and magnetic susceptibility studies. Many forms of modern equipment and current techniques are in use, such as the electron microscope, a selection of X-ray methods including a computer-controlled X-ray four-circle goniometer, cryogenics, gamma ray spectrometers and neutron activation and other equipment to obtain a great variety of physical measurements. Research is also done on the design of experimental

models and stress- and strain-measuring apparatus for rock mechanics research.

Mineralogy

Mineralogists use interdisciplinary approaches to undertake crystal field studies of minerals, such as the nature of bonding between atoms and research on the use of optical absorption techniques to determine coordination relationships. The field also includes stability studies of sulphides and associated ore minerals, electron probe studies of the distribution of elements in mineral assemblages, and ore microscopy — detailed examinations of ore deposits to determine the kind and distribution of minerals, particularly the identification of problems and their solution in the recovery and processing of minerals in industrial operations.

Applied mathematics

Mathematicians seek solutions to theoretical problems encountered, for instance, in the strength of materials (metallurgy and mining), and in physics and chemistry problems in the study of properties and processing of complex naturally occurring minerals; they evolve numerical models and analyze statistical data by modern computational methods.

Metallurgical engineering

Metallurgical engineers conduct research on metals and alloys under different service conditions and on the weldability of metals and metal forming. They study failure mechanisms of metals under various stress environments and the devising of improved alloys; and they do research and investigations in process metallurgy that include unit process studies, such as comminution, flotation, etc., and integrated processes in pilot plants on physical concentration on metallic and nonmetallic ores. They also do research, by hydrometallurgical studies, on lean ores that are amenable to chemical treatment and carry out pilot-plant studies on the reduction of metal concentrates by novel pyrometallurgical techniques.

Fuel chemistry and chemical engineering

Chemists and chemical engineers are concerned with the evaluation of crude oils and natural gases; structural studies of heavy and impure hydrocarbons; research on morphology and chemistry of catalysts; design, construction and operation of high pressure refining equipment particularly in catalytic cracking and hydrogenation processes; the evaluation of coking coals and cokes by chemical, physical and petrographic methods; research on evaluating coking coal and improving the production and quality of coke and special carbons for the metallurgical industry, including the operation of bench and technical scale coking ovens and reactors.

Mechanical engineering

Mechanical engineers carry out research to improve the combustion properties of various fuels in different types of equipment to obtain maximum performance and reduce atmospheric pollution to the minimum.

Opportunities are also available for mechanical engineering research in the design of rigs and pilot plants.

Civil and mining engineering

Civil and mining engineers do various studies in rock mechanics (stability of mines and rock breakage) by explosives and other means; dust and gases in mines; optimization of systems like material handling, employing operational research techniques.

Chemistry, engineering physics and electrical and mechanical engineering

The Branch has two unique laboratories for research on explosives and explosives atmospheres, that have openings for chemists, engineering physicists, electrical and mechanical engineers.

The Observatories Branch

The Observatories Branch is concerned with the physical nature and other characteristics of the stars and members of the solar system, the deep interior of the earth, the earth's crust and the earth's atmosphere. The Branch operates the Dominion Observatory, Ottawa; the Dominion Astrophysical Observatory, Victoria, B.C.; and the Dominion Radio Astrophysical Observatory, Penticton, B.C. The work at Ottawa covers positional astronomy, stellar physics and three geophysical subjects: gravity, magnetism and seismology. A number of subsidiary stations are maintained across Canada where daily geophysical and astronomical observations are required in particular localities.

Graduates in physics, mathematics, astronomy, geology and geophysics are needed in the Branch for studies of astronomy and astrophysics, seismology, heat flow, terrestrial magnetism and gravity.

Astronomy and astrophysics

Astronomers, astrophysicists and mathematicians study the position, composition and physical properties of stars and galaxies through both optical and radio astronomy; they determine time from the stars and maintain the Time Service of Canada, and make special studies of the sun, of meteorites and of meteorite craters.

Seismology

Seismologists maintain the Branch's network of 27 seismograph stations throughout the country for the recording of earthquakes in Canada and throughout the world. The records of this network are made available to the international scientific community and form the basis for research, within the Branch, into problems of wave propagation and earth structure.

The Branch is responsible for Canadian studies into methods of detecting and identifying nuclear explosion. It cooperates with other nations in this vital problem.

Heat flow

A small group of **geophysicists** is employed full time in studying heat flow in wells, drilled in various parts of Canada, and in coordinating the work done by university groups.

Geomagnetism

Geophysicists and mathematicians maintain the Branch's network of nine geomagnetic observatories throughout Canada, the data from which are made available to the international geomagnetic community. They form the basis for much research within the Branch on the earth's magnetic field and its relation to properties of the earth's interior, the upper atmosphere and space. Data from these stations are augmented by measurements of electric currents flowing within the earth's crust.

Since the north magnetic pole lies within Canada, the Branch has the responsibility of plotting its movement. Similarly all data on declination within Canada, as used on maps and charts, are provided by the Branch which also publishes charts of the magnetic field at regular intervals. An airborne magnetometer is used, in part, to provide the necessary data; this instrument has also been flown over the north Atlantic and much of Europe.

Gravity

Geologists, mathematicians and physicists are responsible for the gravity survey of Canada. They interpret the data to provide information on the properties of the earth's crust and surface layers and on the shape of the earth. They also study tides within the solid earth.

training

Financial assistance for graduate studies is available where these studies relate to the programs of the Mines and Geosciences Group.

Postdoctorate fellowships, tenable in the Mines and Geosciences Group, are available through cooperative arrangements with the National Research Council.

salaries

Salaries offered to new university graduates at the Bachelor, Master and Ph.D. levels are normally competitive with those offered by other Canadian employers.

benefits

The benefits are many and varied. Subject to change by collective bargaining, they include ten statutory holidays a year plus three weeks' vacation; fifteen days of sick leave annually, which, if unused, accumulates from year to year; enrolment in one of the most comprehensive superannuation plans in Canada, under which a pension can be as much as seventy per cent of the average salary of the six-year period of highest earnings; low-cost term insurance and, if desired, enrolment in an excellent surgical-medical plan.

how to apply

Recruiting teams, coordinated by the Public Service Commission, visit Canadian universities from coast to coast each year during November, December and January. Details of interview dates and locations, and application forms are available from your Placement Officer. Bulletin board announcement of these dates are also displayed on the campus in late fall.

Further information about positions available in the Department of Energy, Mines and Resources may be obtained from Mr. R. B. Code, Director, Personnel and Organization, Department of Energy, Mines and Resources, 588 Booth Street, Ottawa 4, Ontario.

summer employment

The government service begins its search for prospective employees long before they graduate. Each summer it employs students to work in its departments. In the field, laboratory and office, they become an integral part of staff and make a valuable contribution to departmental engineering, scientific and administrative activities. The students usually receive travel assistance.

For further information and application forms, contact your University Placement Office.

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